1899MNRAS..59..341D

No.	Pulkowa List.	Name.	Mag.	Obsr.	Inst.	Phase.	Cape Sid. Time.			Greenwich M.T.			Remarks.
							h	m	s	h	m	s	
7	42	B.D. + 24°, 1305	9·2	H.	Heliom.	"	7	16	36·0	11	36	48·8	Good.
"	"			L.	18-in.	"	7	16	36·9	11	36	49·7	
"	"			I.	7	"	7	16	37·3	11	36	50·1	Very good.
"	"			V.L.	10	"	7	16	36·9	11	36	49·7	Good.
8	–	B.D. + 24°, 1311	9·4	L.	18	"	7	25	55·7	11	46	6·9	Bad definition.
9	49	Arg. + 24°, 1310	9·2	"	"	"	7	26	53·2	11	47	4·3	
10	48	B.D. + 24°, 1309	9·0	H.	Heliom.	"	7	30	35·5	11	50	46·0	Very good.
"	"			L.	18-in.	"	7	30	35·4	11	50	45·9	
"	"			I.	7	"	7	30	35·4	11	50	45·9	Very good.
"	"			V.L.	10	"	7	30	35·5	11	50	46·0	Good.
11	47	B.D. + 24°, 1308	9·3	I.	7	"	7	31	58	11	52	8	Worthless.
"	"			V.L.	10	"	7	31	58·7	11	52	8·9	Fair, faint.
12	56	B.D. + 24°, 1313	9·2	L.	18	"	7	53	40·7	12	13	47·4	
"	"			I.	7	"	7	53	42	12	13	48	Worthless.
"	"			V.L.	10	"	7	53	41·2	12	13	47·9	Bad.

Royal Observatory, Cape of Good Hope:
1899 *January* 6.

On the Use of the Electric Light for the Artificial Star of a Zöllner Photometer. By W. de Sitter.

(*Communicated by David Gill, C.B., &c., H.M. Astronomer at the Cape.*)

During the last few months I have been engaged on photometric work in connection with an investigation of the systematic difference between visual and photographic magnitudes of stars in the Milky Way and near its poles.

The instrument used is the 6-inch equatorial, by Grubb, belonging to the Cape Observatory, to which an ordinary Zöllner photometer has been adapted in the way recommended by Zöllner (*Photometrische Untersuchungen*, Plates V. and VI.). As is fully explained in Zöllner's work, the paraffin lamp was automatically kept in a horizontal position while the telescope was being driven by the clockwork. On nights without wind the lamp performed very satisfactorily, and remained practically constant throughout the time of observation—usually from 1½ to 2 hours. But there are very few nights without wind at the Cape; and when the south-easter was blowing with its usual velocity of between 15 and 30 miles an hour, it was absolutely impossible to observe. This induced me to try to

1899MNRAS..59..341D

replace the oil lamp by an electric lamp, the light of which would not be affected by the wind. As this is, so far as I know, the first trial ever made of the use of electric light in stellar photometry, I have thought it not without interest to publish my first experiences. Professor Müller writes (*Photometrie der Gestirne*, p. 252): "Eine grosse Gefahr ist das durch Wind und Luftzug hervorgebrachte Flackern der Flamme, welches namentlich das Beobachten im Freien wesentlich erschwert. Man kann sich zwar durch zweckmässige Construction der Blechcylinder, wie es bei den Potsdamer Photometern geschehen ist, theilweise dagegen schützen, es würde aber eine wesentliche Verbesserung des Apparates erzielt werden können, wenn es gelänge, anstatt der Petroleum-Lampe das elektrische Licht nutzbar zu machen . . . , und es kann nicht dringend genug zu Versuchen in dieser Richtung aufgefordert werden."

At first I simply put a 4-volt lamp in place of the oil lamp. The arrangement was then as follows:—The electric lamp was fixed to the brass bar which before carried the oil lamp, and was so adjusted that the light of a portion of the glowing filament fell through the small pinhole at the end of the photometer tube. The light after traversing the tube in the direction of its optical axis, and after passing through the various Nicol prisms, was reflected at an angle of 45° to form an image in the focus of the eyepiece. This image was a very sharp one, and more constant, as well as more star-like, than that formed by the oil lamp; and the equality of brightness of the real and artificial stars could be established quicker and with greater certainty than before.

But I found at the same time that the optical axis of the instrument did not coincide with its axis of rotation, and no adjustment could bring it to coincidence. In fact, there is no definite "axis of rotation." The rotating part of the instrument is not a circle resting on pivots, but a tube rotating inside another tube, and the mechanical fit is not so perfect (and, indeed, cannot be expected to be so in an instrument of this size and quality) as not to allow a certain irregular amount of play in the direction of the instantaneous axis of rotation. With the oil lamp, where a portion of a broad and practically uniformly illuminated surface is used, this introduced no appreciable error, but with the electric lamp the consequence was that in different positions of the rotating tube a different part, or a part of different size, of the glowing filament was used, so that the observations were not strictly comparable.

This error would perhaps be eliminated to a great extent by observing in the four quadrants; but a far better idea was suggested by Dr. Gill, viz. to have the lamp fixed to the end of the tube, so that it would rotate with it, and the relative positions of lamp, pinhole, and optical parts of the instrument would remain unchanged while the tube was rotated on its axis. This plan has been executed, and gives very good results.

1899MNRAS..59..341D

To the end of the tube is clamped a piece of ebonite, in which a $3\frac{1}{2}$-volt lamp is fixed in an adjustable manner. The current is supplied from two accumulator cells in series, placed in the basement of the Observatory, and completely charged twice a week. These cells have a capacity of 130 ampère-hours, and yield a current having a practically constant E.M.F. of 4 volts.

From the cells the current is brought to the top of the pillar, and thence through free-hanging flexible wires to the lamp, so that there is nowhere any spring contact, which might introduce a difference of resistance in different positions of the instrument. No other lamps are fed from the same cells, and I find that the light is not only absolutely constant throughout the observations of one night, but generally even from night to night. A resistance coil has been introduced into the circuit, which enables me to regulate the brightness of the artificial star so as to avoid very small readings, for which the accuracy is not so great as between 10° and 50°. I can now make accurate observations of stars from the 1st to the 11th magnitude.

The weather has been extraordinarily bad this season, so that I had no time to make special observations for the purposes of this paper, and those now quoted simply form part of my regular observations. I observed every star in the four quadrants. The circle is divided from 0° to 180° in two directions, the reading 90° corresponding to the maximum brightness, and 0° and 180° to entire extinction. If there were no index error, and no systematic errors in the instrument, and no errors of observation, the readings in the four quadrants would be :—

$$\phi,\ 180^\circ-\phi,\ 180^\circ-\phi,\ \phi.$$

In reality the four readings are :—

$$\phi_1,\ 180^\circ-\phi_2,\ 180^\circ-\phi_3,\ \phi_4.$$

If we take the means of the readings in two adjacent quadrants, such as

$$\phi_{1\cdot2}=\tfrac{1}{2}(\phi_1+\phi_2)\qquad \phi_{1\cdot4}=\tfrac{1}{2}(\phi_1+\phi_4)$$
$$\phi_{3\cdot4}=\tfrac{1}{2}(\phi_3+\phi_4)\qquad \phi_{2\cdot3}=\tfrac{1}{2}(\phi_2+\phi_3),$$

the index error will be eliminated from these means. Now it is easy to see that any systematic error depending on the position of the rotating tube will have opposite effects on $\phi_{1\cdot2}$ and $\phi_{3\cdot4}$, and also on $\phi_{1\cdot4}$ and $\phi_{2\cdot3}$.

I therefore tabulated the differences $\phi_{1\cdot2}-\phi_{3\cdot4}$ and $\phi_{1\cdot4}-\phi_{2\cdot3}$ for a number of observations made on different nights in November and December of last year. The third and fourth columns of the following table give these differences, arranged in order of magnitude, of the mean of the four readings :—

1899MNRAS..59..341D

Wt. Nr.	ϕ_0	$\phi_{1\cdot2}-\phi_{3\cdot4}$	$\phi_{1\cdot4}-\phi_{2\cdot3}$	Δ_1	Δ_2	Wt. Nr.	ϕ_0	$\phi_{1\cdot2}-\phi_{3\cdot4}$	$\phi_{1\cdot4}-\phi_{2\cdot3}$	Δ_1	Δ_2
	°	°	°	m	m		°	°	°	m	m
1	8·4	−0·3	+1·2	−·04	+·16	32	22·8	−4·9	+1·2	−·22	+·05
2	8·5	+1·0	−0·6	+·13	−·08	33	23·0	+0·6	+1·7	+·03	+·07
3	8·8	+1·5	+1·0	+·19	+·12	34	23·0	+2·0	−1·6	+·09	−·07
4	9·9	−0·5	+1·0	−·06	+·11	35	23·0	+2·0	+2·0	+·09	+·09
5	10·5	+0·6	+0·6	+·06	+·06	36	23·9	+2·2	+1·8	+·10	+·08
6	10·7	+1·0	+1·0	+·10	+·10	37	24·8	+2·5	+3·5	+·10	+·14
7	11·8	+0·5	−1·5	+·05	−·14	38	24·9	+0·9	+4·9	+·04	+·20
8	12·2	−0·5	−1·0	−·04	−·09	39	26·8	+6·5	0	+·26	0
9	13·2	−2·0	+0·5	−·16	+·04	40	29·8	−0·3	−0·4	−·01	−·01
10	15·8	+0·5	−0·5	+·03	−·03	41	30·4	+0·8	+2·3	+·03	+·08
11	15·8	−1·5	−0·5	−·10	−·03	42	30·5	−3·0	+4·0	−·10	+·13
12	15·8	+0·7	−1·3	+·05	−·08	43	33·4	−0·3	−2·3	−·01	−·07
13	17·1	−1·3	+1·3	−·08	+·08	44	34·1	+2·2	−0·2	+·07	−·01
14	18·0	+4·0	+1·0	+·24	+·06	45	34·8	−2·0	+2·0	−·05	+·05
15	18·2	+1·5	+1·5	+·09	+·09	46	36·0	+1·0	−0·4	+·02	−·01
16	18·2	+2·0	+4·5	+·12	+·27	47	41·4	−3·2	+4·7	−·06	+·09
17	18·5	+0·6	+1·0	+·04	+·06	48	42·5	+3·0	−1·0	+·06	−·02
18	18·6	+2·3	−0·3	+·14	−·02	49	48·0	+1·0	−2·0	+·02	−·04
19	19·0	−0·4	+2·0	−·02	+·12	50	50·8	−1·0	+6·8	−·02	+·10
20	19·2	+3·7	+1·6	+·19	+·08	51	53·5	+1·0	0	+·02	0
21	19·9	−1·8	+2·7	−·09	+·14	52	56·6	+2·8	+2·0	+·04	+·03
22	20·0	−1·0	+1·0	−·05	+·05	53	56·8	−1·5	−1·5	−·02	−·02
23	20·9	+0·7	−1·3	+·03	−·06	54	57·0	0	+3·0	0	+·04
24	20·9	−0·3	−0·4	−·02	−·02	55	58·2	+0·5	−0·5	+·01	−·01
25	21·3	+3·4	−3·5	+·16	−·17	56	58·8	−9·5	−3·5	−·11	−·04
26	21·6	+1·7	+0·5	+·08	+·02	57	70·2	−2·5	+1·5	−·01	+·01
27	22·0	+0·4	−3·0	+·02	−·13	58	70·6	−3·2	+4·3	−·02	+·02
28	22·5	−3·0	−2·6	−·13	−·11	59	76·8	+6·5	+0·5	+·03	+·02
29	22·6	+0·8	+1·2	+·04	+·05	60	82·0	+3·0	−3·0	+·01	−·01
30	22·6	+0·4	+0·8	+·02	+·04	61	82·4	−6·8	+6·7	−·03	+·03
31	22·7	+1·0	0	+·04	0						

The residuals $\phi_{1\cdot2}-\phi_{3\cdot4}$ and $\phi_{1\cdot4}-\phi_{2\cdot3}$ are very small, and it will be seen from the table that there is no regularity in the distribution of the positive and negative signs. We may safely conclude that *there is no appreciable systematic error in the instrument*, and that therefore the residuals are due to pure accidental errors of observation. On that supposition the difference $\phi_{1\cdot2}-\phi_{3\cdot4} = \frac{1}{2}(\epsilon_1 + \epsilon_2) - \frac{1}{2}(\epsilon_3 + \epsilon_4)$, where ϵ_1 is the error of ϕ_1, &c. These differences are therefore equivalent to errors of observation of one single pointing, or to twice the error of the mean of four pointings. Accordingly in the fifth and sixth columns I have given the numbers of the third and fourth columns divided by two and converted into magnitudes. Treating these as the residuals in the method of least squares, we find for the probable error of one observation, consisting of four pointings,

$$\pm 0^{m}{\cdot}061.$$

1899MNRAS..59..341D

The results given in this paper must only be considered as of a preliminary character. I intend to make a more thorough investigation of the instrument as soon as I can do so without seriously interfering with my regular observations.

Royal Observatory, Cape of Good Hope:
1899 *January* 3.

The Greenwich Meridian Observations of Polaris, 1836–1893, *with reference to Personality, the value of the Constant of Aberration, and the Star's parallax.* By W. G. Thackeray.

Some years ago, when discussing the observations of *Polaris* with the view of obtaining a value of the nutation constant, the results were likewise arranged with the purpose of determining the annual errors, but it was afterwards found that to include the two discussions in one paper made it too cumbersome, and so the latter part was omitted and the papers have lain dormant since. In turning out some old papers I have lately come upon them, and I append this short preface as an explanation why the right ascensions are reduced in the present form, and how it is that reference is made below to personal equations.

The right ascensions here dealt with are those extending from 1836 to 1893, and are divided into two periods. The first includes the observations made with the transit instrument from 1836 to 1850, and the second those made with the transit circle from 1851 to 1893. They have been all reduced to the year 1890·0 with the Struve-Peters value of precession, with the adopted value of the proper motion for 1890 of $+0^{s}\cdot1550$, the value which was obtained from the discussion on the constant of nutation (*Mem. R.A.S.* vol. li.). They have further been corrected for personal equation to the adopted standard observer "C" by the quantities given in Table III. on p. 252 of the paper referred to above, a process which involved a considerable amount of work, and of which it seems desirable to preserve a record.

The values for any monthly mean are the combination of the results above and below pole, weighted according to the number of observations, and are given uncorrected for personality as well as corrected for personality.

The observations in January and February are mostly below-pole observations, those in July and August above-pole observations, but no observation is kept for place unless the azimuth error has been determined from the consecutive transits of one of the close circumpolars.

The observations have been taken direct from the "Greenwich Observations," and those for 1836–1850 have been corrected further to reduce them to the value of the aberration constant 20·445.